

# **Draft Groundwater Monitoring Report** **Pioneer Builders Supply**

**South Tacoma Field Site**  
**Tacoma, Washington**

**The Burlington Northern and  
Santa Fe Railway Company**

K/J 966124.06

July 1998

**Kennedy/Jenks Consultants**

USEPA SF



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8 July 1998

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Subject: Draft Groundwater Monitoring Report, Pioneer Builders Supply  
South Tacoma Field, Tacoma, Washington  
K/J 966124.06

Dear Ms. Grandinetti:

Enclosed are three copies of the Draft Groundwater Monitoring Report for Pioneer Builders Supply as required by the Statement of Work. According to the project schedule, EPA should provide comments regarding this report within 3 weeks. If you have any questions regarding this report, please call us at (253) 874-0555.

Very truly yours,

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Enclosure

cc: Bruce Sheppard, The Burlington Northern and Santa Fe Railway Company  
Colin Wagoner, ICF Kaiser

**GROUNDWATER MONITORING REPORT  
PIONEER BUILDERS SUPPLY  
South Tacoma Field Site  
Tacoma, Washington**

**DRAFT**

**Prepared for**

**THE BURLINGTON NORTHERN AND SANTA FE RAILWAY COMPANY**

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**8 July 1998**

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## EXECUTIVE SUMMARY

This report provides the objectives, investigative methods, and findings of a supplemental groundwater investigation performed at the Pioneer Builders Supply (Pioneer) site (site) in Tacoma, Washington. This report also provides the conclusions that were made based on data gathered during this investigation and past investigations at the site, and provides recommendations regarding future activity at the site.

The technical approach for the work performed during this investigation was described in the Sampling and Analysis Plan (SAP) provided as Appendix A of the South Tacoma Field (STF) Remedial Design Work Plan (Kennedy/Jenks Consultants 1997a). The work was performed at the request of the U.S. Environmental Protection Agency (EPA) Region 10 in order to provide information to supplement the data gathered during the groundwater investigation at the site during the STF Remedial Investigation (RI).

Three underground storage tanks (USTs) were discovered in the northeast corner of the Pioneer property in early 1990 and were excavated and disposed of in June 1990. Based on the discovery of chemicals of concern (COCs) in soil, a number of investigations were performed at the Pioneer site during the 1991-1992 STF RI. Groundwater sampling at well NMW-1A indicated the presence of total petroleum hydrocarbons (TPH), aromatic fuel constituents [benzene, toluene, ethylbenzene, and xylenes, (BTEX)], volatile organic compounds (VOCs), and semivolatile organic compounds (semivolatiles).

The following work was performed during the supplemental groundwater investigation:

- Collection of reconnaissance groundwater samples from 10 locations surrounding monitoring well NMW-1A to assist in placement of additional groundwater monitoring wells



- Construction and development of four monitoring wells, and quarterly sampling of the four new monitoring wells and monitoring well NMW-1A for one year
- Collection of reconnaissance groundwater samples from three vertical intervals at one location.

The upper aquifer at the site occurs in poorly graded to well-graded sand with varying amounts of gravel and silt. Groundwater was encountered at depths of about 25 to 30 feet below ground surface (bgs) during the 1997-1998 quarterly sampling events. Groundwater hydraulic gradient directions were highly variable at the site during the monitoring period. The gradient directions were consistent with the variable and reversible nature of regional groundwater flow that was observed during the 1991-1992 STF RI groundwater monitoring activities.

Benzene, ethylbenzene, naphthalene, TPH as gasoline (TPH-G), and TPH as diesel (TPH-D) were detected in two of the five monitoring wells (NMW-1A and NMW-10A) during the 1997-1998 groundwater monitoring period at concentrations exceeding one or both of the following regulatory criteria:

- Cleanup levels specified in Table 9-4 of the Record of Decision (ROD) or Washington State Department of Ecology Model Toxics Control Act (MTCA) Method B groundwater cleanup
- Federal Maximum Contaminant Levels (MCLs).

The estimated first-order decay rates ( $k$ ) at the Pioneer site were calculated for benzene, naphthalene, TPH-G, and TPH-D to evaluate the time required for natural attenuation of those constituents to concentrations less than the applicable regulatory criteria. Based on the results of these calculations, the time estimated for contaminant concentrations in groundwater at the Pioneer site to attain MCLs and/or cleanup level endpoints is less than 4 years for benzene, less than 3 years for TPH-G and TPH-D, and less than 1 year for naphthalene.

Based on the results of this supplemental groundwater investigation, Kennedy/Jenks Consultants recommends no further action at the site, other than assessing the progress of natural attenuation during the first 5-year review following completion of remedial action activities.



## 1.0 INTRODUCTION

This report provides the objectives, investigative methods, and findings of a supplemental groundwater investigation performed at the Pioneer Builders Supply (Pioneer) site (site) in Tacoma, Washington. This report also provides the conclusions that were made based on data gathered during this investigation and past investigations at the site, and provides recommendations regarding future activity at the site.

The technical approach for the work performed during this investigation was described in the Sampling and Analysis Plan (SAP) provided as Appendix A of the South Tacoma Field (STF) Remedial Design Work Plan (Kennedy/Jenks Consultants 1997a). The work was performed at the request of the U.S. Environmental Protection Agency (EPA) Region 10 in order to provide information to supplement the data gathered during the groundwater investigation at the site during the STF Remedial Investigation (RI).

### 1.1 BACKGROUND AND SITE HISTORY

Pioneer operates a wholesale sales and distribution facility for roofing and building materials at the site property. Pioneer purchased the property from Burlington Northern Railroad in May 1986, and constructed a warehouse and office building on the property in 1988.

Pioneer used two underground storage tanks (USTs) for approximately 5 years to store gasoline and diesel fuel. Pioneer excavated the USTs in December 1991 and determined that the surrounding soil was contaminated with petroleum products (Saltbush Environmental Services 1992). In addition, three USTs were discovered in the northeast corner of the Pioneer property in early 1990 and were excavated and disposed of in June 1990 [Tacoma-Pierce County Health Department (TPCHD) 1991]. These three USTs reportedly were empty when discovered. Soil samples were

collected from the 1990 UST excavation, and chemicals of concern (COCs) were detected.

Based on the discovery of COCs in soil, a number of investigations were performed at the Pioneer site during the STF RI, including soil, soil gas, and groundwater investigations. Groundwater sampling at monitoring well NMW-1A indicated the presence of total petroleum hydrocarbons (TPH), aromatic fuel constituents [benzene, toluene, ethylbenzene, and xylenes, (BTEX)], volatile organic compounds (VOCs), and semivolatile organic compounds (semivolatiles).

## 1.2 PREVIOUS INVESTIGATIONS

During the 1990 UST removal work, soil samples were collected from the north end, middle, and south end of the UST removal excavation beginning at a depth of 10 feet below ground surface (bgs). One composite soil sample was collected at a depth of 8 feet bgs. TPCHD collected a second set of soil samples at the same locations (i.e., north end, middle, and south end of the excavation) at a depth of 15 to 17 feet bgs. Concentrations of TPH detected in the soil samples increased with increasing depth. The concentrations of TPH detected in soil samples were as high as 9,788 milligrams per kilogram (mg/kg). In addition to analyses for TPH, analyses for total halogenated hydrocarbons and BTEX were performed. Results of laboratory analyses for halogenated hydrocarbons indicated that 1,2-dichlorobenzene; 1,4-dichlorobenzene; 1,2-dichloropropane; and 1,1,2,2-tetrachloroethane were present in the soils (ICF Technology, Incorporated 1990).

Based on the soil sampling results, extensive investigative activities were performed at the STF site during the 1991-1992 RI. The purpose of these activities was to estimate the extent of impacted soil and to assess the potential for impacts to groundwater from UST releases. Investigative activities performed at the Pioneer site as part of the STF RI included:

- Drilling of nine soil borings, and collection and analysis of 51 subsurface soil samples
- Collection and analysis of 35 soil gas samples from 24 locations
- Construction of one shallow groundwater monitoring well (NMW-1A) in the middle of the former UST excavation; collection and analysis of groundwater samples from that well quarterly for one year (April 1991 through January 1992); and measurement of groundwater levels in that well monthly for one year (April 1991 through March 1992).

Groundwater samples collected from monitoring well NMW-1A during the STF RI contained detectable concentrations of BTEX, VOCs, and semivolatiles. A summary of constituents detected in groundwater at Pioneer during the STF RI is provided in Appendix A.

In 1995, groundwater samples were collected from monitoring well NMW-1A to assess the change in COC concentrations over time. Concentrations of COCs were found to have decreased from the concentrations detected during the 1991-1992 STF RI. Analytical results for the 1995 groundwater samples are summarized in the table presented in Appendix A.

### 1.3 OBJECTIVES

The general objective of the supplemental groundwater investigation was to provide data to supplement the groundwater investigation performed at the Pioneer site during the STF RI. The specific objective of the supplemental groundwater investigation was to collect data regarding the vertical and horizontal distribution of COCs in shallow groundwater surrounding monitoring well NMW-1A, and temporal variations in COC concentrations in shallow groundwater.



## **1.4 WORK PERFORMED**

Field methods and laboratory analyses for the supplemental groundwater investigation were provided in the SAP and are summarized in the following sections.

### **1.4.1 Reconnaissance Groundwater Sampling**

Ten reconnaissance groundwater samples (RGW-1 through RGW-10) were collected on 28 and 29 April 1997 at the locations shown on Figure 1. The objective of reconnaissance groundwater sampling and analyses was to provide qualitative data regarding the lateral distribution of COCs in groundwater to assist in placement of shallow groundwater monitoring wells around NMW-1A.

Reconnaissance groundwater samples were collected using a StrataProbe rig operated by Transglobal Environmental Geosciences Northwest, Inc. (TEG). The StrataProbe advanced a hollow steel probe to the target depth of about 2 feet below the top of the uppermost saturated zone (i.e., about 27 feet bgs) using a hydraulic hammer. The probe was then retracted about 18 inches. A flexible 0.25-inch inside-diameter sample hose with a 6-inch-long stainless steel mesh screen was then inserted through the steel probe and down to the bottom of the probe hole. A peristaltic pump was used to extract groundwater from the boring through the sample hose.

Samples were transferred directly into the appropriate sample container and preserved with hydrochloric acid (HCL) (for BTEX and gasoline-range hydrocarbons only). Samples were then immediately labeled and placed in an iced cooler for transportation to the analytical laboratory. Reconnaissance groundwater samples were transported to TEG's fixed-base analytical laboratory in Lacey, Washington for analysis within a 12-hour turnaround time. Reconnaissance groundwater samples were analyzed for:

- BTEX using EPA Method 8020

- Gasoline-range petroleum hydrocarbons (TPH-G) using the Washington TPH as gasoline (WTPH-G) Method
- Diesel-range petroleum hydrocarbons (TPH-D) using the Washington TPH as diesel (WTPH-D) Method.

#### 1.4.2 Shallow Groundwater Monitoring Well Installation

Four shallow groundwater monitoring wells (NMW-8A, NMW-9A, NMW-10A, and NMW-11A) were constructed on 7 May 1997 in the locations shown on Figure 1. The locations of these wells were selected based on the findings of the reconnaissance groundwater sampling and were approved by EPA prior to well construction.

Locations of the wells were selected to provide groundwater quality data in the following areas:

- NMW-8A--upgradient of the source area
- NMW-10A--downgradient of NMW-1A and inside the area of affected groundwater
- NMW-9A--near the downgradient edge of the area of affected groundwater
- NMW-11A--along the eastern Pioneer property boundary and downgradient of the source area.

Monitoring well borings were drilled using 4.25-inch inside-diameter hollow-stem augers (HSA) and a truck-mounted drill rig. Soil samples were collected during drilling at approximately 5-foot vertical intervals using a 2.5-inch outside diameter stainless steel split spoon sampler. The sampler was lined with brass sleeves and was typically driven about 18 inches into the undisturbed soil ahead of the HSA drill string lead auger



cutting head. The soil conditions encountered at each boring location were logged in accordance with the Unified Soil Classification System (USCS; ASTM D2488 Standard Practice for Description and Identification of Soils: Visual-Manual Procedure).

Monitoring wells were constructed inside the HSA drill stem to facilitate proper placement of well materials. Monitoring wells were constructed of 2-inch-diameter Schedule 40 PVC casing and 0.010-inch factory machine-slotted screens. The screened intervals of the wells were typically selected to intersect the water table with about 10 feet of screen above and about 15 feet of screen below (i.e., a 25-foot screened interval) the unsaturated/saturated zone interface. During monitoring well drilling, shallow groundwater was encountered at about 27 feet bgs and the screened interval typically extended from about 17 to 42 feet bgs. A filter pack consisting of #10/20 clean washed silica sand was placed to a depth of 3 feet above the top of the screened interval and the remainder of the well boring was backfilled with granular bentonite. Each well was completed with an aboveground monument and protective traffic bollards. Monitoring well completion details are provided on the boring and well construction logs (Appendix B). Monitoring wells were constructed in accordance with *Minimum Standards for Construction and Maintenance of Wells* (WAC 173-160).

At the completion of monitoring well construction, the horizontal location and vertical elevation of each of the new wells was surveyed by Earth Tech of Federal Way, Washington. The survey data for these wells are provided in Appendix C.

The new groundwater monitoring wells were developed after construction to remove fines from the wells and to minimize future migration of the fines into the wells.

Groundwater samples were collected quarterly for one year beginning in May 1997. Field measurements were recorded on groundwater purge and sample forms (Appendix D). Groundwater samples were transmitted to Analytical Resources, Inc. (ARI) located in Seattle, Washington and analyzed for the following constituents:

- TPH-G using WTPH-G

- TPH-D using WTPH-D
- VOCs using EPA Method 8260.

#### **1.4.3 Vertical Characterization Groundwater Sampling**

One deep (75 ft) soil boring (RGW-11) was drilled on 8 May 1997 about 10 feet north of monitoring well NMW-1A (see Figure 1). The objective of advancing this boring was to provide data to assess the potential for vertical migration of chlorinated VOCs within the shallow aquifer.

One reconnaissance groundwater sample was collected from each of three depths in the deep boring: at 55 feet, 65 feet, and 75 feet bgs. A truck-mounted drill rig and HSAs were used to drill the deep soil boring. At each target sample depth a Hydropunch-type sampler was inserted into the HSA drill stem and advanced about 18 inches into the soil ahead of the HSA lead auger cutting head. A groundwater sample was then collected from the Hydropunch-type sampler using a 0.5-inch diameter bailer. The groundwater sample was placed directly into the appropriate sample container and preserved with HCL (where applicable). The sample was then immediately labeled and placed in an iced cooler for transportation to the analytical laboratory. The Hydropunch-type sampler was removed from the HSA drill stem and the boring was advanced to the next target sampling depth. The sample collection process was then repeated.

The Hydropunch-type sampler was disassembled and steamcleaned between sampling events, and a new bailer assembly was used to collect each sample.

Reconnaissance groundwater samples were submitted to CCI Analytical Laboratories Inc. in Everett, Washington initially for analysis of BTEX using EPA Method 8020, TPH-G using WTPH-G, and TPH-D using WTPH-D. Subsequently, grab groundwater

samples from the 55-foot and 75-foot levels were analyzed for VOCs using EPA Method 8260.



## 2.0 PHYSICAL SETTING

### 2.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The upper aquifer at the Pioneer site is the Colvos Sand unit of the Vashon Drift. The Colvos Sand unit is composed mainly of fine- to medium-grained poorly graded to well-graded sand with minor gravel and silt (Kennedy/Jenks Consultants 1992). The Colvos Sand represents advance outwash sands and gravels that were deposited from meltwater streams along the leading edge of the glacier during its southward advance.

In general, the regional groundwater system in the uppermost unconfined aquifer is characterized by recharge in the Fircrest/Tacoma upland with shallow groundwater flow east to the Puyallup River Valley and west to Puget Sound. The divide between east and west flow occurs in the vicinity of the South Tacoma Channel (Black & Veatch 1990), where the Pioneer site is located. Pioneer is located within the Clover/Chambers Creek surface water drainage basin. The general direction of the groundwater hydraulic gradient in this basin is southeast to northwest (Brown and Caldwell 1985). This hydraulic gradient direction is consistent with the hydraulic gradient direction that was observed during the STF site RI when the City of Tacoma was not pumping from their wellfield to the east of the STF site (Kennedy/Jenks Consultants 1992). The STF site, including Pioneer, lies within a groundwater recharge area. Seasonal variations in groundwater levels and reversals due to pumping of the City of Tacoma production wells were observed during the STF RI.

### 2.2 LOCAL GEOLOGY AND HYDROGEOLOGY

Soil types encountered during drilling at the Pioneer site during this investigation and during the STF RI ranged from silty sand to gravel. The uppermost saturated zone occurs in poorly graded to well-graded sand with varying amounts of gravel and silt. Details of soil types detected during drilling of monitoring wells NMW-1A, NMW-8A,

NMW-9A, NMW-10A, and NMW-11A are shown on the boring and well construction logs (Appendix B).

Groundwater was encountered at depths of about 25 to 30 feet bgs during the 1997-1998 sampling events. Groundwater levels were measured during the four quarterly sampling events in May 1997, August 1997, December 1997, and March 1998. Depths to groundwater and groundwater elevations are summarized in Table 1.

Groundwater levels measured in wells during the 1997-1998 monitoring period were contoured and plotted on Figures 2 through 5. Groundwater hydraulic gradient directions were highly variable at the site during this monitoring period. The gradient directions were consistent with the variable and reversible nature of regional groundwater flow that was observed during the STF RI groundwater monitoring activities.



### 3.0 LABORATORY ANALYTICAL RESULTS

#### 3.1 RECONNAISSANCE GROUNDWATER SAMPLES FOR MONITORING WELL PLACEMENT

One or more of the BTEX compounds, TPH-G, and TPH-D were detected in groundwater samples collected from four of the 10 reconnaissance sampling locations (i.e., in RGW-2, RGW-3, RGW-6, and RGW-8). The reconnaissance sampling locations are shown on Figure 1. The laboratory analytical results are summarized in Table 2; laboratory analytical reports are provided in Appendix E. The results of this reconnaissance sampling were used to select the locations for additional monitoring wells.

#### 3.2 SAMPLES OF GROUNDWATER FROM MONITORING WELLS

The four new monitoring wells and monitoring well NMW-1A were sampled quarterly for one year beginning in May 1997. Locations of the monitoring wells are shown on Figure 1. The laboratory analytical results are summarized in Tables 3A through 3D. The laboratory analytical reports for quarterly groundwater sampling are provided in Appendix F. Validation of the quarterly groundwater sampling data was performed by Kennedy/Jenks Consultants. The data validation reports are provided in Appendix G.

Benzene, ethylbenzene, naphthalene, TPH-G, and TPH-D were detected in samples collected from two of the five monitoring wells (NMW-1A and NMW-10A) during the 1997-1998 groundwater monitoring period at concentrations exceeding one or both of the following:

- Cleanup levels specified in Table 9-4 of the Record of Decision (ROD) or Washington State Department of Ecology Model Toxics Control Act (MTCA) Method B groundwater cleanup levels

- Federal Maximum Contaminant Levels (MCLs).

For all other constituents analyzed, one or more of the following conditions applied:

- The constituents were not detected
- The constituents were detected but concentrations were less than cleanup levels and MCLs
- Cleanup levels and MCLs were not available.

Concentrations of benzene, ethylbenzene, naphthalene, TPH-G, and TPH-D that were detected at concentrations exceeding cleanup levels and/or MCLs are listed in Table 4.

### **3.3 RECONNAISSANCE SAMPLES OF VERTICAL GROUNDWATER INTERVALS**

Laboratory analytical results of the grab groundwater sampling for vertical groundwater quality characterization are provided in Appendix H. Following initial analysis for BTEX, TPH-D, and TPH-G, samples collected from the 55-foot and 75-foot depths were analyzed for all VOCs by EPA Method 8260. Holding times were slightly exceeded for the subsequent VOC analyses; however, comparison of results from the initial BTEX analyses (within holding times) and subsequent VOC analyses showed good correlation, indicating that holding time exceedances should not have significantly impacted the results.

Evaluation of the vertical characterization results indicate that a positive bias was introduced into the samples during the sample collection procedure; however, the results generally indicated that vertical migration of chlorinated VOCs did not appear to be of significant concern since they were not detected in any of the samples collected. Based on discussions between Mr. Nathan Graves of Kennedy/Jenks Consultants and Ms. Cami Grandinetti of EPA Region 10, it was agreed that the results were useable for

## 4.0 ESTIMATES OF DECAY RATES FOR CHEMICALS OF CONCERN

Natural attenuation (including intrinsic bioremediation) will reduce concentrations of organic chemicals detected in groundwater at the Pioneer site over time. Dissolved oxygen (DO) is the most thermodynamically favored electron acceptor used by naturally occurring microorganisms in the biodegradation of fuel hydrocarbons (Wiedemeier et al. 1995a). The concentrations of DO in groundwater were measured during two of the four quarterly monitoring events to provide an indication of DO available for biodegradation. DO concentrations are summarized in Table 5. The results show that DO is present in site groundwater at concentrations sufficient to support intrinsic biodegradation of fuel hydrocarbons. This conclusion is supported by the observed decrease in the organic solute concentrations over time. As with a large number of processes, the change in solute concentration in groundwater over time can be described using a first-order decay constant derived as follows (Wiedemeier, et al. 1995a):

$$\text{(Equation 1) } C_t = C_0 e^{-kt}$$

$$\text{(Equation 2) } \ln \frac{C_0}{C_t} = -kt$$

$$\text{(Equation 3) } k = -\frac{\ln C_0 / C_t}{t}$$

$$\text{(Equation 4) } t = -\frac{\ln C_0 / C_t}{k}$$

Overall, attenuation rates (first-order rate constants,  $k$  values) for the Pioneer site were calculated for benzene, naphthalene, TPH-G, and TPH-D using Equation 3, where:

- $C_0$  = The highest concentration of each solute detected in monitoring well NMW-1A during the four 1991 quarterly monitoring events (except TPH-D and TPH-G, where 1995 data were used as these parameters were not analyzed for during the 1991-1992 RI).



- $C_t$  = The concentration of each solute detected in monitoring well NMW-1A during the December 1997 quarterly monitoring event (December 1997 was used to represent recent worst-case results).
- $t$  = Time (in days) elapsed between  $C_0$  and  $C_t$ .

Using the  $k$  values derived from Equation 3, the time ( $t$ ) required for each solute to decay to the selected concentration endpoint ( $C_t$ ) was then extrapolated using Equation 4, where the selected concentration endpoint was the lowest of the following concentration values for each constituent:

- Cleanup level
- MCL.

The initial concentration used for this extrapolation calculation was the highest of the concentrations of a solute reported for any well sampled during the 1997-1998 groundwater monitoring period. The results of these calculations are provided in Table 6. The first order rate constants calculated for benzene and naphthalene are consistent with, but slightly lower than, the low range for anaerobic decay rates for the compounds reported by Wiedemeier, et al. (1995b) and MacIntyre, et al. (1993).

Based on the results of the first-order decay rate calculations, the time estimated for solute concentrations in groundwater at the Pioneer site to attain cleanup levels and/or MCLs is less than 4 years for benzene, less than 3 years for TPH-G and TPH-D, and less than 1 year for naphthalene.

A first-order decay rate was not calculated for ethylbenzene, as ethylbenzene was not detected during the December 1997 sampling event at concentrations above cleanup levels and/or MCLs.

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

### 5.1 SUMMARY AND CONCLUSIONS

The saturated zone at the Pioneer site was encountered in poorly graded to well-graded sand with varying amounts of gravel and silt, at depths of approximately 25 to 30 feet bgs. Groundwater hydraulic gradient directions were highly variable at the site from May 1997 through March 1998, the period monitored quarterly for this investigation.

Benzene, ethylbenzene, naphthalene, TPH-G, and TPH-D were detected in two of the five monitoring wells (NMW-1A and NMW-10A) during the 1997-1998 groundwater monitoring period at concentrations exceeding cleanup levels and/or MCLs. In general, concentrations of these compounds have decreased considerably since the RI as well as sampling performed in 1995. During the May 1997 through 1998 monitoring period, chemical concentrations appear to be steady or decreasing during the last three events.

Based on the present distribution of contaminants exceeding these regulatory levels in groundwater, there does not appear to be an identifiable potentially completed pathway to a receptor that would pose an unacceptable human health or ecological risk.

Site-specific data were used to calculate first-order decay rates for these constituents. Based on extrapolations using these calculated rates, estimates of the time necessary for natural attenuation of contaminant concentrations in groundwater at the Pioneer site to achieve cleanup level and/or MCL endpoints are less than 4 years for benzene, less than 3 years for TPH-G and TPH-D, and less than 1 year for naphthalene.



## 5.2 RECOMMENDATIONS

Because natural attenuation processes for petroleum hydrocarbons and aromatic fuel constituents have been demonstrated to be reliable processes that lead to the attainment of cleanup endpoints, and these processes are expected to decrease concentrations of contaminants at the site below regulatory levels in less than 4 years, it is not necessary to evaluate options for additional action at the site. Kennedy/Jenks Consultants recommends that no further action be performed at the Pioneer site, other than assessing the progress of natural attenuation during the first 5-year review following completion of remedial action activities.

## 6.0 REFERENCES

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[illegible]



**TABLE 1**  
**GROUNDWATER ELEVATION MEASUREMENTS**  
**Pioneer Builders Supply**

Well I.D.	Elevation of Top of Well Casing (feet)	May 1997		August 1997		December 1997		March 1998	
		Depth to Water (feet)	Water Level Elevation (ft MSL)	Depth to Water (feet)	Water Level Elevation (ft MSL)	Depth to Water (feet)	Water Level Elevation (ft MSL)	Depth to Water (feet)	Water Level Elevation (ft MSL)
NMW-1	252.72	27.29	225.43	29.88	222.84	30.66	222.06	27.86	224.86
NMW-8	253.93	28.45	225.48	31.03	222.90	31.82	222.11	29.08	224.85
NMW-9	253.79	28.42	225.37	30.97	222.82	31.77	222.02	28.96	224.83
NMW-10	253.78	28.38	225.40	31.03	222.75	31.77	222.01	28.93	224.85
NMW-11	253.94	28.47	225.47	31.00	222.94	31.91	222.03	29.11	224.83

TABLE 1

**PAHs, VOCs, AND TPH DETECTED IN GROUNDWATER SAMPLES COLLECTED  
FROM PIONEER BUILDERS SUPPLY MONITORING WELL NMW-1A**

Analyte	April 1991	July/Aug. 1991	Oct./Nov. 1991	Jan. 1992	Aug. 1995	Cleanup Levels <sup>(a)</sup>
<b>PAHs (ug/L)</b>						
Naphthalene	130 J2	190	68	30	46	32
Acenaphthylene	U 1.0	U 1.0	U 1.0	U 1.0	63	NA <sup>(b)</sup>
Acenaphthene	U 0.5	3	2.6	1.8	40	960 <sup>(c)</sup>
Fluorene	U 0.1	4	U 0.1	U 0.1	0.31	640 <sup>(c)</sup>
Phenanthrene	U 0.05	0.14	U 0.05	U 0.05	U 0.64	NA
Fluoranthene	U 0.1	U 0.1	U 0.1	U 0.1	0.94	640 <sup>(c)</sup>
<b>VOCs (ug/L)</b>						
Acetone	E 410 R	J 78	U 50	U 10	U 50	800 <sup>(c)</sup>
1,1,2-Trichloroethane	U 10	J 51	U 50	U 10	U 50	5
Benzene	E 300 R	480	D 230	86	J 33	5
Toluene	E 470 R	770	D 170	51	160	1,000
Ethyl Benzene	E 570 R	1,000	D 600	150	460	700
Styrene	U 10	U 100	U 50	J 3	U 50	NA
Xylenes (total)	E 1,100 R	2,300	DJ 644	141	540	10,000
<b>TPH-G (mg/L)</b>						
Gasoline Range	Not analyzed	Not analyzed	Not analyzed	Not analyzed	11	1
<b>TPH-D (mg/L)</b>						
Diesel Range	Not analyzed	Not analyzed	Not analyzed	Not analyzed	3	1

Notes: Letters preceding the concentration values are laboratory qualifiers. Letters following the concentration value are data validation qualifiers. (Data validation has not been performed on the August 1995 data.) A "U" qualifier indicates the analyte was not detected at the concentration indicated.

- (a) From Table 9-4 of the Record of Decision, Commencement Bay South Tacoma Channel, South Tacoma Field Operable Unit (EPA Region 10, September 1994) unless noted otherwise.
- (b) Not applicable. Cleanup levels are not available for these compounds.
- (c) Model Toxics Control Act Cleanup Regulation Method B cleanup level (from 3 August 1994 Cleanup Levels and Risk Calculation Update).

**TABLE 2**

**RECONNAISSANCE GROUNDWATER ANALYTICAL RESULTS**

**APRIL 1997 SAMPLING EVENT**

**Pioneer Builders Supply**

Chemical	RGW-1	RGW-2	RGW-3	RGW-4	RGW-5	RGW-6	RGW-7	RGW-8	RGW-9	RGW-10
Volatile Organic Compounds (VOCs) (µg/L) <sup>(a)</sup>										
Benzene	<1.0 <sup>(b)</sup>	<b>41</b>	<b>7</b>	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	<b>220</b>	<b>8</b>	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	<1.0	<b>450</b>	<b>30</b>	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Xylenes	<1.0	<b>1,200</b>	<b>32</b>	<1.0	<1.0	<b>17</b>	<1.0	<b>10</b>	<1.0	<1.0
Total Petroleum Hydrocarbons (TPH) (mg/L)										
TPH as gasoline <sup>(c)</sup>	<0.1	<b>46,000</b>	<b>1,900</b>	<0.1	<0.1	<b>488</b>	<0.1	<b>520</b>	<0.1	<0.1
TPH as diesel <sup>(d)</sup>	<0.2	<0.2	<0.2	<0.2	<0.2	<b>1,211</b>	<0.2	<b>819</b>	<0.2	<0.2

Notes:

- (a) Groundwater samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA Method 8020.
- (b) "<" denotes analyte was not detected at the indicated detection limit.
- (c) Groundwater samples were analyzed for TPH as gasoline using WTPH-G
- (d) Groundwater samples were analyzed for TPH as diesel using WTPH-D

Concentrations above the detection limit are shown in bold.



TABLE 3A

**GROUNDWATER ANALYTICAL RESULTS**  
**FIRST QUARTER SAMPLING EVENT - MAY 1997**  
**Pioneer Builders Supply**

Analyte	Monitoring Well					MCLs <sup>(c)</sup>	Cleanup Levels <sup>(d)</sup>
	NMW-1A	NMW-8A	NMW-9A <sup>(a)</sup>	NMW-10A <sup>(a)</sup>	NMW-11A/NMW-101 <sup>(a,b)</sup>		
Volatile Organic Compounds (µg/L) <sup>(e)</sup>							
Acetone	5.2	<5.0	<5.0	57	7.6/6.9	-- <sup>(f)</sup>	800
Benzene	<1.0	<1.0	<1.0	14	<1.0/<1.0	5.0	5.0
Toluene	<1.0	<1.0	<1.0	100	<1.0/<1.0	1,000	1,000
Ethylbenzene	<1.0	<1.0	<1.0	600	<1.0/<1.0	700	700
m,p-Xylene	<1.0	<1.0	<1.0	970	<1.0/<1.0	10,000	10,000
o-Xylene	<1.0	<1.0	<1.0	120	<1.0/<1.0	10,000	10,000
1,3,5-Trimethylbenzene	<1.0	<1.0	<1.0	230	<1.0/<1.0	--	--
1,2,4-Trimethylbenzene	<1.0	<1.0	<1.0	570	<1.0/<1.0	--	--
Isopropylbenzene	<1.0	<1.0	<1.0	81	<1.0/<1.0	--	--
n-Propylbenzene	<1.0	<1.0	<1.0	99	<1.0/<1.0	--	--
sec-Butylbenzene	<1.0	<1.0	<1.0	13	<1.0/<1.0	--	--
4-Isopropyltoluene	<1.0	<1.0	<1.0	23	<1.0/<1.0	--	--
n-Butylbenzene	<1.0	<1.0	<1.0	19	<1.0/<1.0	--	--
Naphthalene	<5.0	<5.0	<5.0	310	<5.0/<5.0	--	320
1,2,3-Trichlorobenzene	9.8	<5.0	<5.0	<50	<5.0/<5.0	--	--
Total Petroleum Hydrocarbons (mg/L)							
TPH as gasoline <sup>(g)</sup>	<0.25	<0.25	<0.25	16	<0.25/<0.25	--	1.0
TPH as diesel <sup>(h)</sup>	<0.25	<0.25	<0.25	0.32	<0.25/<0.25	--	1.0



## TABLE 3A

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### GROUNDWATER ANALYTICAL RESULTS FIRST QUARTER SAMPLING EVENT - MAY 1997 Pioneer Builders Supply

#### Notes:

- (a) Quality control data from the initial analysis for samples collected from wells NMW-9A, NMW-10A, and NMW-11A were below percent recoveries due to a malfunction of the GC/MS autosampler. These samples were reanalyzed one day after the recommended holding time for VOC analysis. Sample results from both analyses showed good correlation. Therefore, the samples (hence sample results) were deemed to be unaffected by the exceedance of the holding time by one day and were not qualified.
- (b) Sample NMW-101 is a duplicate sample collected from monitoring well NMW-11A.
- (c) Maximum contaminant levels (MCLs) are provided in the Drinking Water Regulations under the Safe Drinking Act, as amended.
- (d) Cleanup levels from Table 9-4 of the Record of Decision (ROD) or the Model Toxics Control Act (MTCA) Method B groundwater cleanup levels based on MTCA Cleanup Levels and Risk Calculations (CLARC II) Update dated February 1996. Recommended daily intake for naphthalene modified in 1994 resulting in a revised MTCA Method B cleanup level of 320 µg/L.
- (e) Samples were analyzed for volatile organic compounds (VOCs) using EPA Method 8260. Only results of detected analytes are summarized in this table.
- (f) "—" denotes that a cleanup level has not been specified in the ROD, or a MCL or MTCA Method B cleanup level is not available.
- (g) Samples were analyzed for total petroleum hydrocarbons as gasoline using WTPH-G.
- (h) Samples were analyzed for total petroleum hydrocarbons as diesel using WTPH-D.

**Concentrations above the detection limits are shown in bold.**

TABLE 3B

**GROUNDWATER ANALYTICAL RESULTS**  
**SECOND QUARTER SAMPLING EVENT - AUGUST 1997**  
**Pioneer Builders Supply**

Analyte	Monitoring Well					MCLs <sup>(b)</sup>	Cleanup Levels <sup>(c)</sup>
	NMW-1A/Duplicate <sup>(a)</sup>	NMW-8A	NMW-9A	NMW-10A	NMW-11A		
Volatile Organic Compounds (µg/L) <sup>(d)</sup>							
Acetone	<5.0/5.8	<5.0	<5.0	25	<5.0	-- <sup>(e)</sup>	800
2-Butanone	<5.0/<5.0	<5.0	<5.0	12	<5.0	--	4,800
Benzene	11/13	<1.0	<1.0	41	<1.0	5.0	5.0
Toluene	3.5/4.1	<1.0	<1.0	340	<1.0	1,000	1,000
Ethylbenzene	10/13	<1.0	<1.0	800	<1.0	700	700
m,p-Xylene	9.1/11	<1.0	<1.0	1,400	<1.0	10,000	10,000
o-Xylene	1.6/1.8	<1.0	<1.0	260	<1.0	10,000	10,000
1,2-Dichlorobenzene	1.6/1.7	<1.0	<1.0	<1.0	<1.0	600	720
1,4-Dichlorobenzene	1.2/1.2	<1.0	<1.0	<1.0	<1.0	75	1.82
1,3,5-Trimethylbenzene	2.3/3.0	<1.0	<1.0	280	<1.0	--	--
1,2,4-Trimethylbenzene	2.8/3.3	<1.0	<1.0	710	<1.0	--	--
Isopropylbenzene	1.7/2.1	<1.0	<1.0	130	<1.0	--	--
n-Propylbenzene	1.6/2.0	<1.0	<1.0	140	<1.0	--	--
sec-Butylbenzene	<1.0/<1.0	<1.0	<1.0	21	<1.0	--	--
4-Isopropyltoluene	<1.0/<1.0	<1.0	<1.0	41	<1.0	--	--
n-Butylbenzene	<1.0/<1.0	<1.0	<1.0	34	<1.0	--	--
1,2,4-Trichlorobenzene	62/80	<5.0	<5.0	<5.0	<5.0	70	80
Naphthalene	<5.0/<5.0	<5.0	<5.0	390	<5.0	--	320
1,2,3-Trichlorobenzene	180/240	<5.0	<5.0	<5.0	<5.0	--	--
Total Petroleum Hydrocarbons (TPH) (mg/L)							
TPH as gasoline <sup>(f)</sup>	0.68/<0.25	<0.25	<0.25	17	<0.25	--	1.0
TPH as diesel <sup>(g)</sup>	1.1/1.1	<0.25	<0.25	1.2	<0.25	--	1.0

## TABLE 3B

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### GROUNDWATER ANALYTICAL RESULTS SECOND QUARTER SAMPLING EVENT - AUGUST 1997 Pioneer Builders Supply

#### Notes:

- (a) Represents a duplicate sample collected from monitoring well NMW-1A.
- (b) Maximum contaminant levels (MCLs) are provided in the Drinking Water Regulations under the Safe Drinking Act, as amended.
- (c) Cleanup levels from Table 9-4 of the Record of Decision (ROD) or the Model Toxics Control Act (MTCA) Method B groundwater cleanup levels based on MTCA Cleanup Levels and Risk Calculations (CLARC II) Update dated February 1996. Recommended daily intake for naphthalene modified in 1994 resulting in a revised MTCA Method B cleanup level of 320 µg/L.
- (d) Samples were analyzed for volatile organic compounds (VOCs) using EPA Method 8260. Only results of detected analytes are summarized in this table.
- (e) "—" denotes that a cleanup level has not been specified in the ROD, or a MCL or MTCA Method B cleanup level is not available.
- (f) Samples were analyzed for total petroleum hydrocarbons as gasoline using WTPH-G.
- (g) Samples were analyzed for total petroleum hydrocarbons as diesel using WTPH-D.

**Concentrations above the detection limits are shown in bold.**



TABLE 3C

**GROUNDWATER ANALYTICAL RESULTS  
THIRD QUARTER SAMPLING EVENT - DECEMBER 1997  
Pioneer Builders Supply**

Analyte	Monitoring Well					MCLs <sup>(b)</sup>	Cleanup Levels <sup>(c)</sup>
	NMW-1A/NMW-100 <sup>(a)</sup>	NMW-8A	NMW-9A	NMW-10A	NMW-11A		
Volatile Organic Compounds (µg/L) <sup>(d)</sup>							
Acetone	5.9/<5.0	<5.0	<5.0	<50	<5.0	-- <sup>(e)</sup>	800
Benzene	9.8/14	<1.0	<1.0	38	<1.0	5.0	5.0
Toluene	9.3/17	<1.0	<1.0	260	<1.0	1,000	1,000
Ethylbenzene	45/76	<1.0	<1.0	680	<1.0	700	700
m,p-Xylene	74/120	<1.0	<1.0	1,200	<1.0	10,000	10,000
o-Xylene	9.7/16	<1.0	<1.0	200	<1.0	10,000	10,000
1,3,5-Trimethylbenzene	17/28	<1.0	<1.0	210	<1.0	--	--
1,2,4-Trimethylbenzene	31/52	<1.0	<1.0	550	<1.0	--	--
Isopropylbenzene	7.9/12	<1.0	<1.0	80	<1.0	--	--
n-Propylbenzene	7.5/12	<1.0	<1.0	92	<1.0	--	--
sec-Butylbenzene	1.2/1.7	<1.0	<1.0	11	<1.0	--	--
4-Isopropyltoluene	3.0/4.3	<1.0	<1.0	22	<1.0	--	--
n-Butylbenzene	1.7/2.5	<1.0	<1.0	16	<1.0	--	--
1,2,4-Trichlorobenzene	21/15	<5.0	<5.0	<50	<5.0	70	80
Naphthalene	13/24	<5.0	<5.0	340	<5.0	--	320
1,2,3-Trichlorobenzene	51/35	<5.0	<5.0	<50	<5.0	--	--
Total Petroleum Hydrocarbons (TPH) (mg/L)							
TPH as gasoline <sup>(f)</sup>	0.67/1.9	<0.25	<0.25	17	<0.25	--	1.0
TPH as diesel <sup>(g)</sup>	1.0/0.86	<0.25	<0.25	2.8	<0.25	--	1.0



TABLE 3C

**GROUNDWATER ANALYTICAL RESULTS  
THIRD QUARTER SAMPLING EVENT - DECEMBER 1997  
Pioneer Builders Supply**

Notes:

- (a) Sample NMW-100 is a duplicate sample collected from monitoring well NMW-1A.
- (b) Maximum contaminant levels (MCLs) are provided in the Drinking Water Regulations under the Safe Drinking Act, as amended.
- (c) Cleanup levels from Table 9-4 of the Record of Decision (ROD) or the Model Toxics Control Act (MTCA) Method B groundwater cleanup levels based on MTCA Cleanup Levels and Risk Calculations (CLARC II) Update dated February 1996. Recommended daily intake for naphthalene modified in 1994 resulting in a revised MTCA Method B cleanup level of 320 µg/L.
- (d) Samples were analyzed for volatile organic compounds (VOCs) using EPA Method 8260. Only results of detected analytes are summarized in this table.
- (e) "—" denotes that a cleanup level has not been specified in the ROD, or a MCL or MTCA Method B cleanup level is not available.
- (f) Samples were analyzed for total petroleum hydrocarbons as gasoline using WTPH-G.
- (g) Samples were analyzed for total petroleum hydrocarbons as diesel using WTPH-D.

**Concentrations above the detection limits are shown in bold.**

TABLE 3D

**GROUNDWATER ANALYTICAL RESULTS  
FOURTH QUARTER SAMPLING EVENT - MARCH 1998  
Pioneer Builders Supply**

Analyte	Monitoring Well					MCLs <sup>(b)</sup>	Cleanup Levels <sup>(c)</sup>
	NMW-1A	NMW-8A	NMW-9A	NMW-10A/NMW-100 <sup>(a)</sup>	NMW-11A		
Volatile Organic Compounds (µg/L) <sup>(d)</sup>							
Acetone	<5.0	<5.0	<5.0	<5.0/5.2	<5.0	-- <sup>(e)</sup>	800
Benzene	6.2	<1.0	<1.0	<1.0/<1.0	<1.0	5.0	5.0
Toluene	2.4	<1.0	<1.0	<1.0/<1.0	<1.0	1,000	1,000
Ethylbenzene	2.7	<1.0	<1.0	4.5/4.9	<1.0	700	700
m,p-Xylene	5.2	<1.0	<1.0	8.9/9.2	<1.0	10,000	10,000
o-Xylene	2.4	<1.0	<1.0	3.2/3.4	<1.0	10,000	10,000
1,3,5-Trimethylbenzene	<1.0	<1.0	<1.0	1.6/1.5	<1.0	--	--
1,2,4-Trimethylbenzene	2.1	<1.0	<1.0	7.7/7.6	<1.0	--	--
Isopropylbenzene	2.0	<1.0	<1.0	<1.0/<1.0	<1.0	--	--
1,2,4-Trichlorobenzene	5.2	<5.0	<5.0	<5.0/<5.0	<5.0	70	80
1,2,3-Trichlorobenzene	13	<5.0	<5.0	<5.0/<5.0	<5.0	--	--
Total Petroleum Hydrocarbons (TPH) (mg/L)							
TPH as gasoline <sup>(f)</sup>	<0.25	<0.25	<0.25	0.26/0.29	<0.25	--	1.0
TPH as diesel <sup>(g)</sup>	0.42	<0.25	<0.25	<0.25/<0.25	<0.25	--	1.0

## TABLE 3D

Page 2 of 2

### GROUNDWATER ANALYTICAL RESULTS FOURTH QUARTER SAMPLING EVENT - MARCH 1998 Pioneer Builders Supply

#### Notes:

- (a) Sample NMW-100 is a duplicate sample collected from monitoring well NMW-10A.
- (b) Maximum contaminant levels (MCLs) are provided in the Drinking Water Regulations under the Safe Drinking Act, as amended.
- (c) Cleanup levels from Table 9-4 of the Record of Decision (ROD) or the Model Toxics Control Act (MTCA) Method B groundwater cleanup levels based on MTCA Cleanup Levels and Risk Calculations (CLARC II) Update dated February 1996. Recommended daily intake for naphthalene modified in 1994 resulting in a revised MTCA Method B cleanup level of 320 µg/L.
- (d) Samples were analyzed for volatile organic compounds (VOCs) using EPA Method 8260. Only results of detected analytes are summarized in this table.
- (e) "—" denotes that a cleanup level has not been specified in the ROD, or a MCL or MTCA Method B cleanup level is not available.
- (f) Samples were analyzed for total petroleum hydrocarbons as gasoline using WTPH-G.
- (g) Samples were analyzed for total petroleum hydrocarbons as diesel using WTPH-D.

**Concentrations above the detection limits are shown in bold.**

**TABLE 4**

**GROUNDWATER SAMPLES WITH EXCEEDANCES OF CLEANUP LEVELS AND/OR MCLs  
Pioneer Builders Supply**

Monitoring Well	Exceedances During Each Quarterly Sampling Event			
	May 1997	August 1997	December 1997	March 1998
NMW-1A	No exceedance	benzene = 11 µg/L TPH-D = 1.1 mg/L	benzene = 9.8 µg/L	benzene = 6.2 ug/L
NMW-10A	benzene = 14 µg/L TPH-G = 16 mg/L	benzene = 41 µg/L ethylbenzene = 800 µg/L naphthalene = 390 µg/L TPH-G = 17 mg/L TPH-D = 1.2 mg/L	benzene = 38 µg/L  naphthalene = 340 µg/L TPH-G = 17 mg/L TPH-D = 2.8 mg/L	No exceedance

**CLEANUP LEVELS AND MCLs**

Analyte	MCL	Cleanup Levels
Benzene	5.0 ug/L	5.0 µg/L
Naphthalene	NA	320 µg/L
Ethylbenzene	700 µg/L	700 µg/L
TPH-G	NA	1.0 mg/L
TPH-D	NA	1.0 mg/L



**TABLE 5**

**CONCENTRATIONS OF DISSOLVED OXYGEN IN GROUNDWATER<sup>(a)</sup>**

**Pioneer Builders Supply**

Well I.D.	May 1997	August 1997	December 1997	March 1998
NMW-1	NM <sup>(b)</sup>	0.83	NM	1.3
NMW-8	NM	6.9	NM	6.8
NMW-9	NM	3.1	NM	4.8
NMW-10	NM	0.82	NM	2.2
NMW-11	NM	0.52	NM	1.6

Notes:

- (a) Concentrations are in mg/L.
- (b) NM = Not measured.

**TABLE 6**

**FIRST-ORDER DECAY RATE CALCULATIONS  
Pioneer Builders Supply**

Calculating  $k$  using data from NMW-1A:

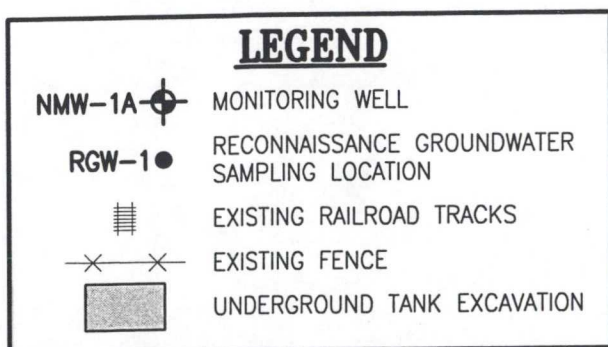
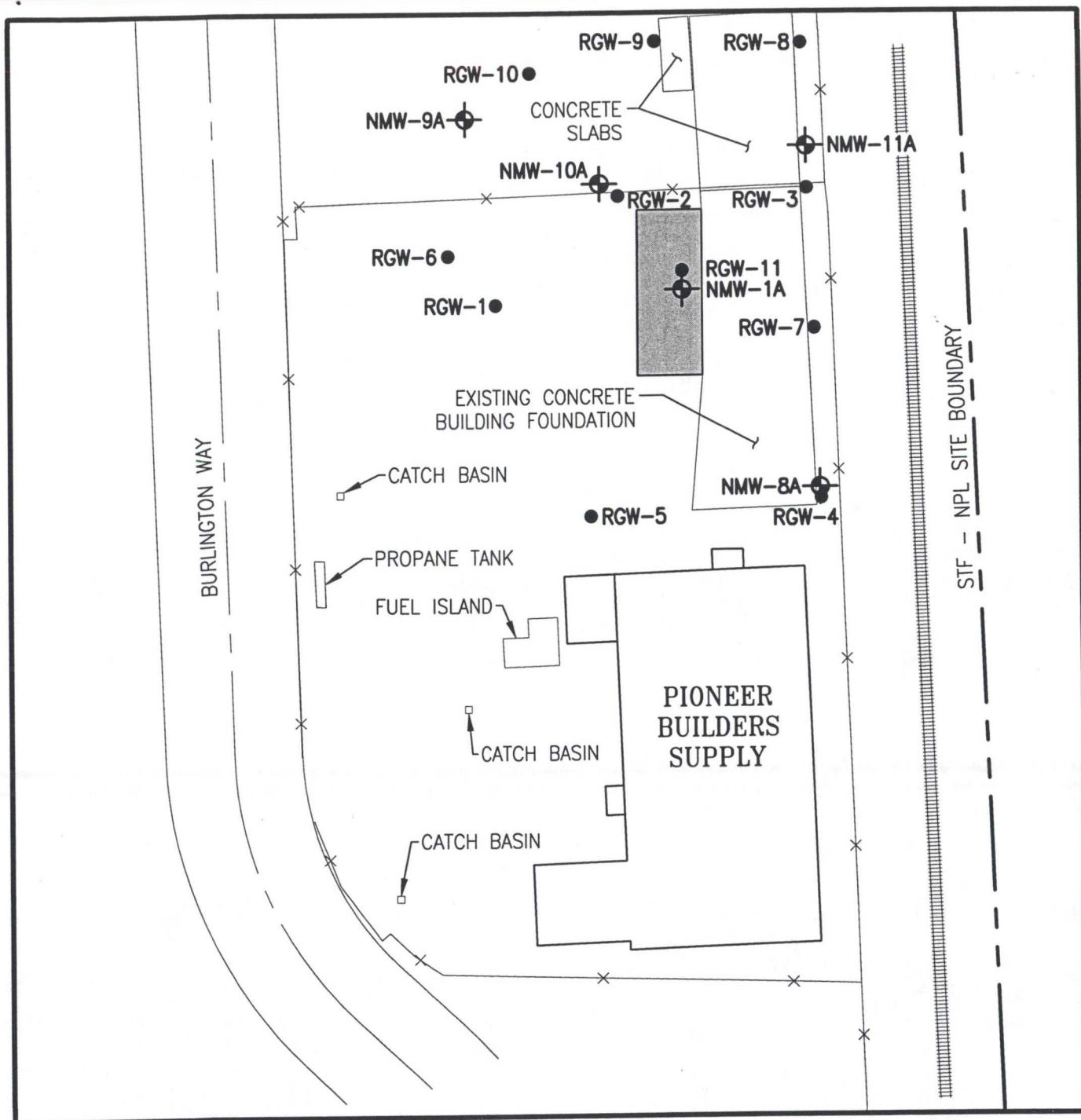
Analyte	$k$	Date Beginning	Date Ending	Time (months)	$t$ (days)	$C_0$	$C_t$
Benzene	0.0016	7/91	12/97	78	2379	480	9.8
Naphthalene	0.0011	7/91	12/97	78	2379	190	13
TPH-G	0.0032	8/95	12/97	29	884	11	0.7
TPH-D	0.0012	8/95	12/97	29	884	3	1.0

Calculating  $t$  using  $k$  values calculated from information above:

Analyte	$C_0$ (date measured)	$C_t$	$k$	$t$ (days)	Time (years)
Benzene	41 (8/97)	5.0	0.0016	1,315	3.6
Naphthalene	390 (8/97)	320	0.0011	180	0.5
TPH-G	17 (12/97)	1.0	0.0032	885	2.4
TPH-D	2.8 (12/97)	1.0	0.0012	858	2.4

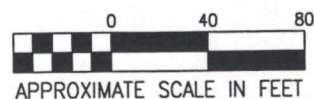
## Figures





**NOTE:**

1) ALL LOCATIONS ARE APPROXIMATE.



**Kennedy/Jenks Consultants**

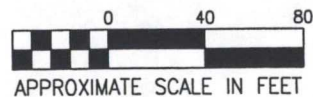
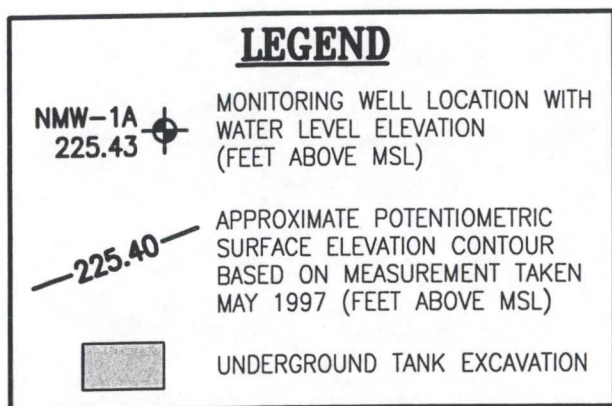
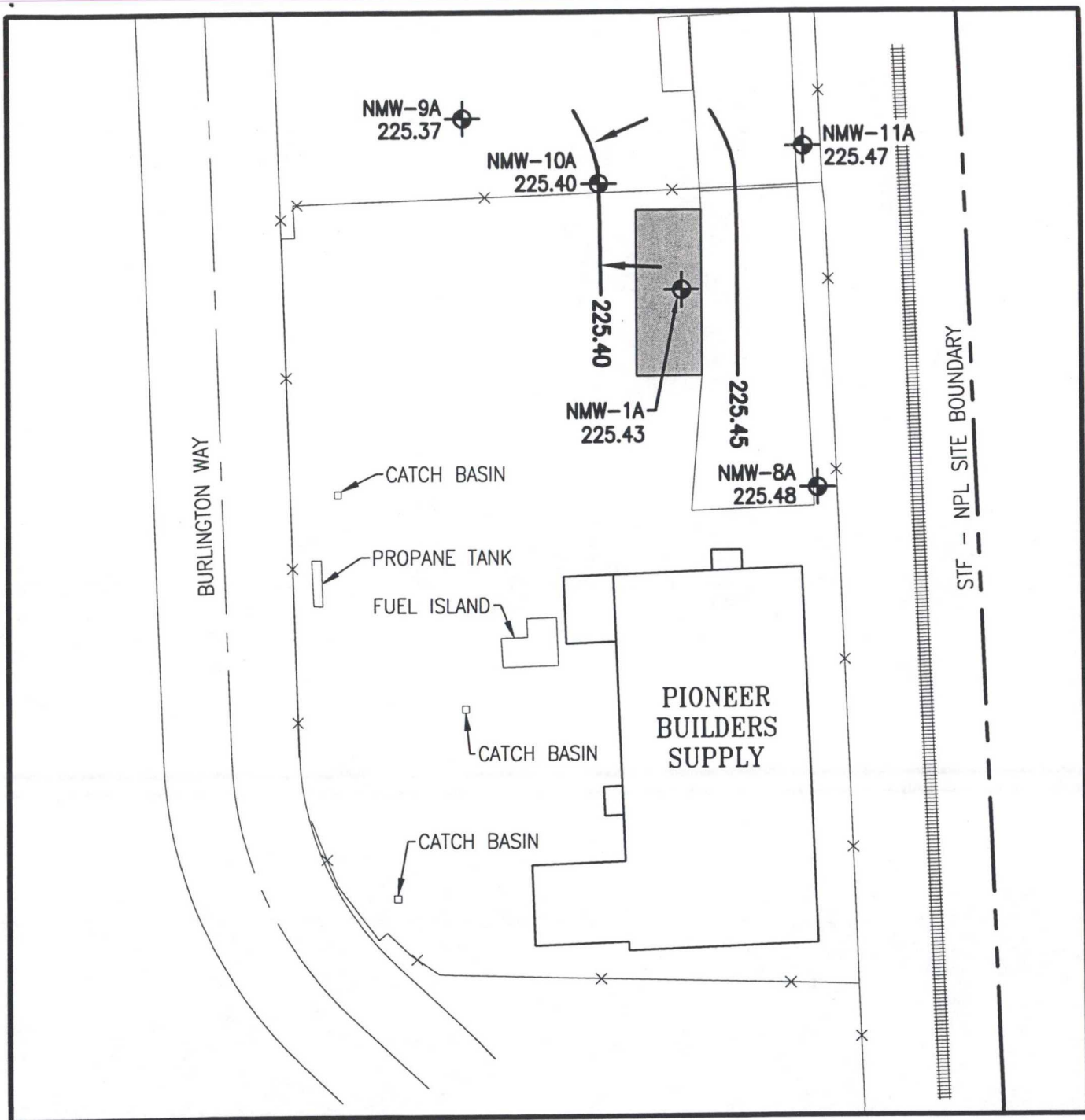
SOUTH TACOMA FIELD  
TACOMA, WA

**PIONEER BUILDERS SUPPLY  
RECONNAISSANCE GROUNDWATER  
SAMPLING AND MONITORING  
WELL LOCATIONS**

966124.06/P8SK001

**FIGURE 1**





**Kennedy/Jenks Consultants**

SOUTH TACOMA FIELD  
TACOMA, WA

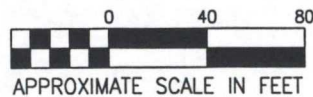
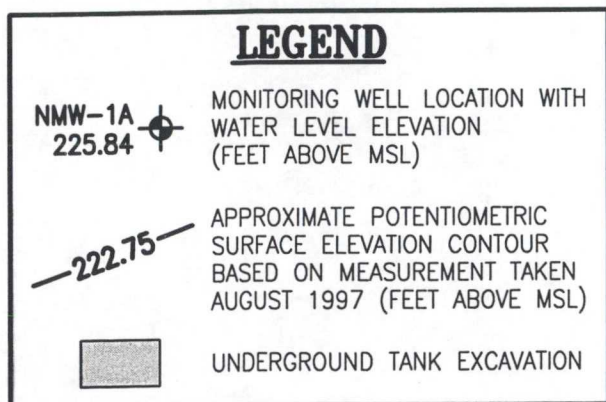
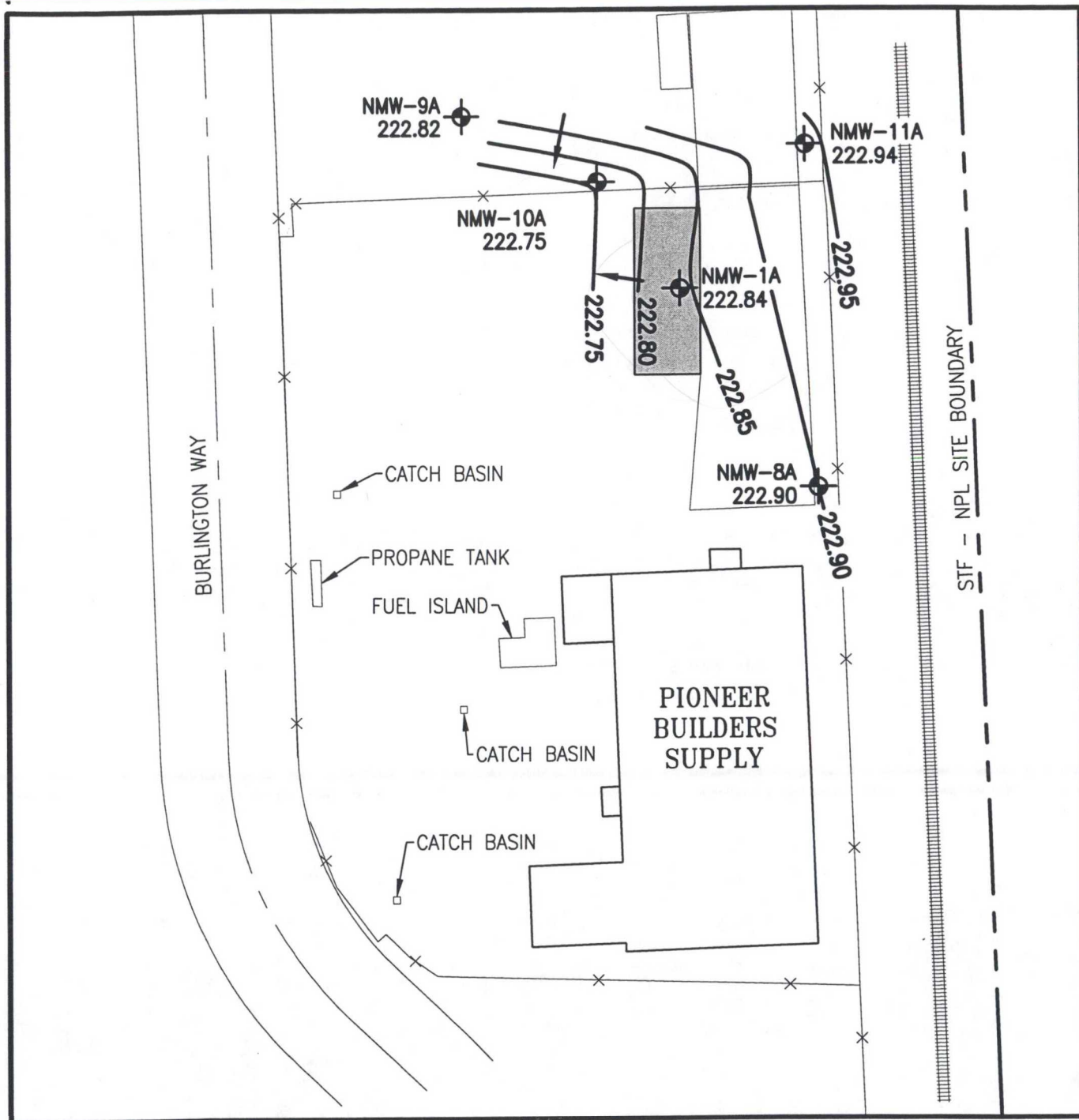
**POTENTIOMETRIC SURFACE CONTOURS  
MAY 1997**

**NOTE:**

- 1) ALL LOCATIONS ARE APPROXIMATE.

966124.06/P8SK002

**FIGURE 2**



**Kennedy/Jenks Consultants**

SOUTH TACOMA FIELD  
TACOMA, WA

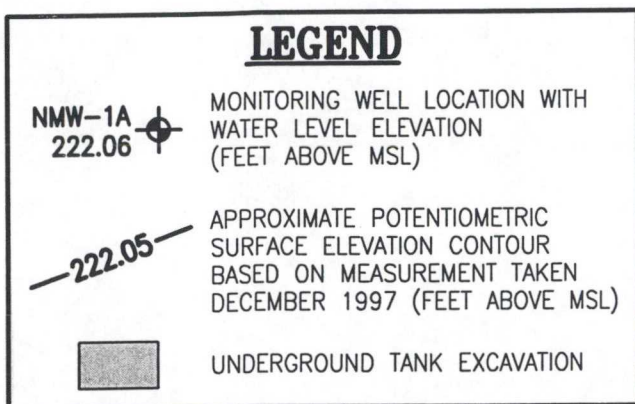
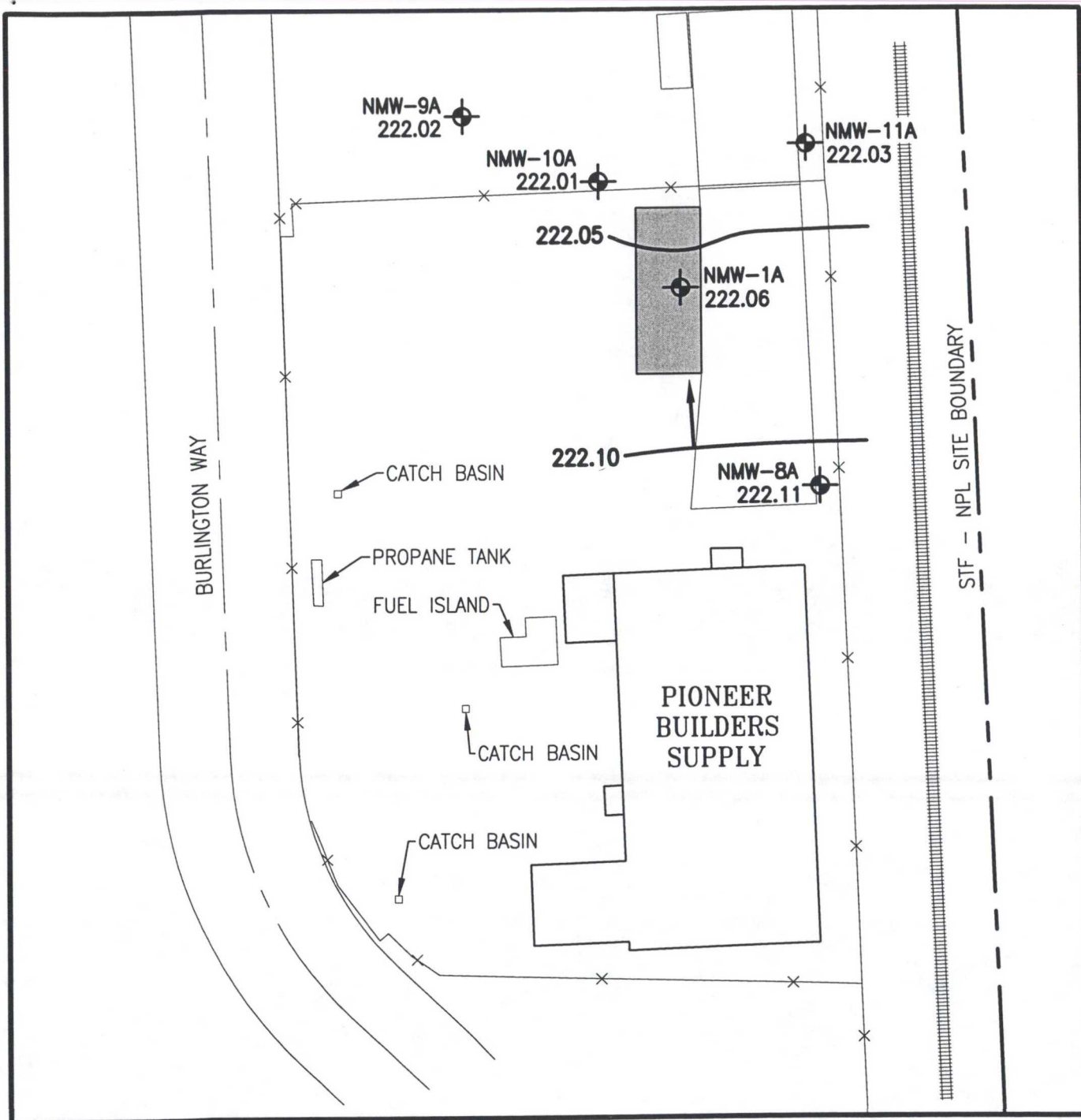
**POTENTIOMETRIC SURFACE CONTOURS  
AUGUST 1997**

**NOTE:**

1) ALL LOCATIONS ARE APPROXIMATE.

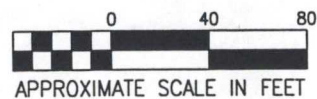
966124.06/P8SK003

**FIGURE 3**



**NOTE:**

1) ALL LOCATIONS ARE APPROXIMATE.



**Kennedy/Jenks Consultants**

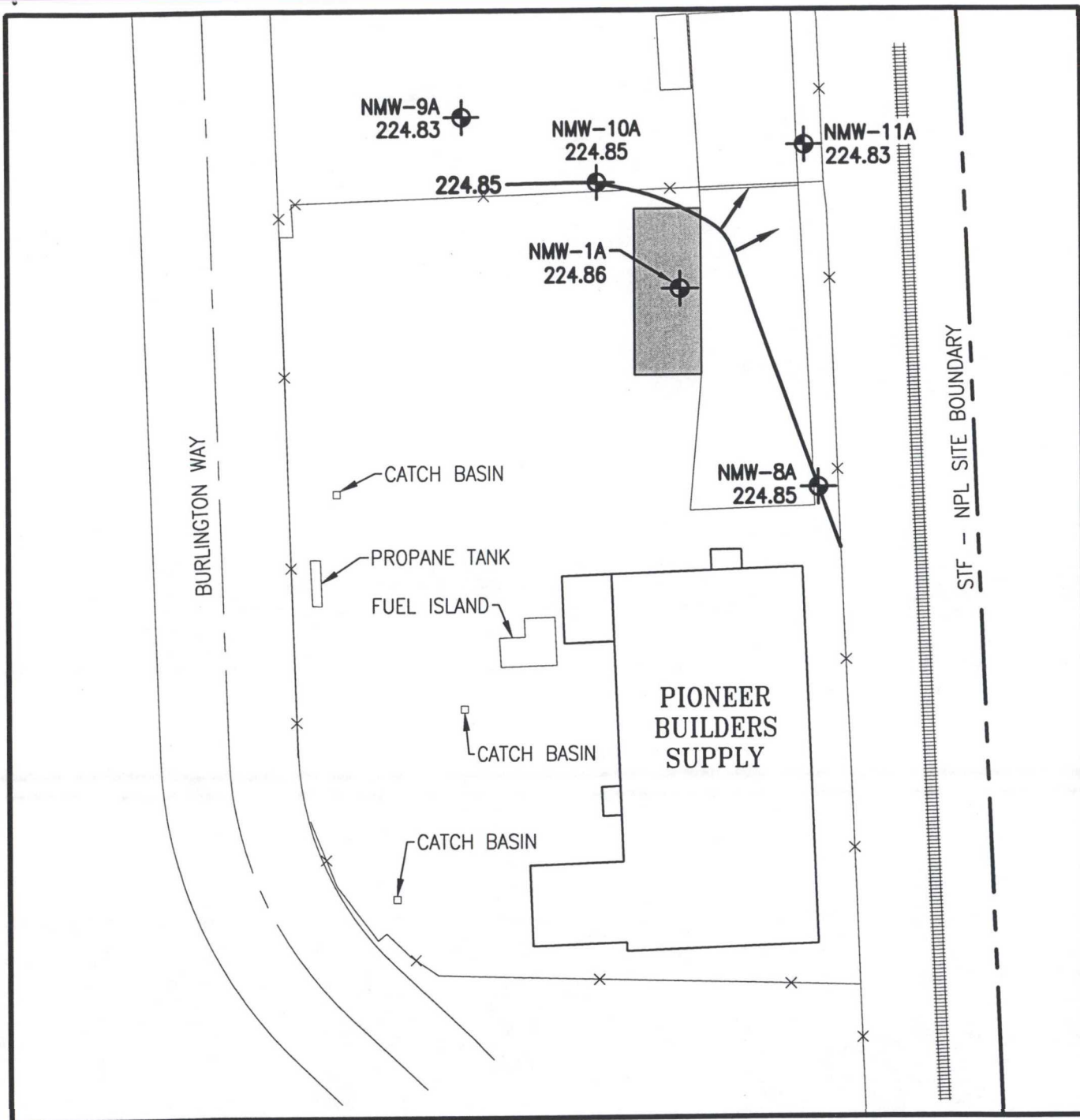
SOUTH TACOMA FIELD  
TACOMA, WA

**POTENTIOMETRIC SURFACE CONTOURS  
DECEMBER 1997**

966124.06/P8SK004

**FIGURE 4**

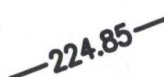




### LEGEND



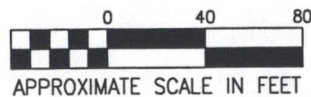
MONITORING WELL LOCATION WITH  
WATER LEVEL ELEVATION  
(FEET ABOVE MSL)



APPROXIMATE POTENTIOMETRIC  
SURFACE ELEVATION CONTOUR  
BASED ON MEASUREMENT TAKEN  
MARCH 1998 (FEET ABOVE MSL)



UNDERGROUND TANK EXCAVATION



**Kennedy/Jenks Consultants**

SOUTH TACOMA FIELD  
TACOMA, WA

**POTENTIOMETRIC SURFACE CONTOURS  
MARCH 1998**

### NOTE:

- 1) ALL LOCATIONS ARE APPROXIMATE.
- 2) ELEVATION CHANGES ARE WITHIN SURVEY/MEASUREMENT  
ERRORS—UNRELIABLE FLOW DIRECTIONS.

966124.06/P8SK005

**FIGURE 5**


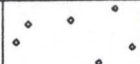

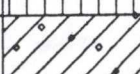
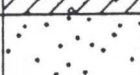
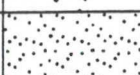
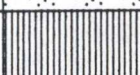






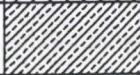



## **Appendix A**

**Analytes Detected in Groundwater Samples  
Collected from Monitoring Well NMW-1A During the  
South Tacoma Field Remedial Investigation and in 1995**



## **Appendix B**

### **Boring and Well Construction Logs**

MAJOR DIVISIONS			GROUP SYMBOL	GRAPHIC SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS GREATER THAN 50% IS LARGER THAN NO. 200 SIEVE	GRAVELS  MORE THAN 50% COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURE.
		GRAVELS WITH OVER 15% FINES	GM		CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND CLAY MIXTURE
			GC		SILTY GRAVELS, POORLY GRADED GRAVEL-SAND CLAY MIXTURES
	SANDS  MORE THAN 50% COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL-GRADED SANDS, GRAVELLY SANDS
			SP		POORLY-GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM		SILTY GRAVELS, POORLY GRADED SAND-SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE-GRAINED SOILS GREATER THAN 50% IS SMALLER THAN NO. 200 SIEVE	SILTS AND CLAYS  LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAY
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS  LIQUID LIMIT GREATER THAN 50%		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
				Pt	

**NOTES:**

- LITHOLOGIC CONDITIONS WERE LOGGED USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) IN APPROXIMATE ACCORDANCE WITH ASTM METHOD 2488D.
- SUBSURFACE INFORMATION FROM BORING AND TEST PIT LOGS DEPICT CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS AT THESE LOCATIONS. ALSO THE CONDITIONS AT THESE LOCATIONS MAY CHANGE WITH TIME.
- BLOW COUNTS INDICATE THE NUMBER OF BLOWS TO DRIVE THE SAMPLER 6 INCHES WITH A 140 POUND HAMMER FALLING 30 INCHES.

- U RELATIVELY UNDISTURBED SAMPLE  
G GRAB SAMPLE (DISTURBED)  
O OTHER TYPE OF SAMPLE  
 GROUNDWATER FIRST ENCOUNTERED  
 WATER LEVEL AND DATE MEASURED  
10/31/90

**KENNEDY/JENKS CONSULTANTS**

SOUTH TACOMA FIELD  
TACOMA, WA

**BORING LOG LEGEND**

916055.08\P1SK117

# **Appendix C**

## **Survey Data**



13.5  
**Kennedy/Jenks Consultants**  
**South Tacoma Field Monitoring Wells**  
**May 16, 1997**

Well ID	Northing	Easting	Elev. North Rim	Elev. PVC (North)
NMW-1A	690017.390	1146754.290	252.91	252.72
ACS-331	690108.450	1146637.660	254.37	253.79
ACS-332	690073.555	1146710.442	254.35	253.78
ACS-333	690092.972	1146820.033	254.32	253.94
ACS-334	689913.357	1146826.292	254.62	253.93

Vertical control based on South Tacoma Field Datum.

Horizontal control based on South Tacoma Field Datum.

Reset soil sample grid points 767, 783, 785, 787, 821, 823, 841, and 879.



## **Appendix D**

### **Groundwater Purge and Sample Forms**

## **Appendix E**

### **Laboratory Analytical Reports for Reconnaissance Groundwater Samples for Well Placement**

## **Appendix F**

### **Laboratory Analytical Reports for Groundwater Samples Collected in 1997 and 1998**



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## May 1997 Sampling Event

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## **August 1997 Sampling Event**

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## **December 1997 Sampling Event**

## **March 1998 Sampling Event**



## **Appendix G**

### **Data Validation Reports for Groundwater Samples Collected in 1997 and 1998**

19 January 1998

**MEMORANDUM**

To: STF File

From: Julie Reid

Subject: Data Validation  
First Quarter Groundwater Analytical Results  
K/J 966124.06

---

This memorandum summarizes the results of the data validation performed on the STF first quarter groundwater sample results. Seven groundwater samples (including one duplicate and one field blank) were collected from Pioneer Builders Supply on 5 May 1997 for the analysis of WTPH-d, WTPH-g, and VOCs. The following components were evaluated during data validation:

- Holding times (verified that samples were analyzed within the specified holding time)
- Laboratory method blank samples [verified that no analytes were present in method blanks and that a blank was analyzed every 20 samples (or more often) for each matrix]
- Field blank samples (verified that no analytes were present in the field blank samples)
- Surrogate spikes (verified that surrogate recoveries have been performed and control limits were met)
- Matrix spikes/matrix spike duplicate samples [verified that matrix spikes (for metal analyses) and matrix spike/matrix spike duplicates (for organic analyses) were analyzed every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met]
- Laboratory check samples (verified that laboratory check sample results, if submitted, met control limits)
- Laboratory duplicate samples (verified that duplicate analyses were conducted every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met)
- Field duplicate samples [calculated relative percent differences (RPDs) for each set of field duplicate samples].

Holding Times

All samples were initially analyzed within the specified holding time. However, samples NMW-9A, NMW-10A, NMW-11A, NMW-101 (duplicate of NMW-11A), and NMW-102 (field blank) were reanalyzed for VOCs because the laboratory control sample associated with the samples had low recoveries due to an autosampler malfunction. The samples were reanalyzed one day past holding time. Original results and the reanalysis results correlated well, demonstrating the validity of the original results.

**MEMORANDUM**

STF File

19 January 1998

Page 2

Blank Samples

No analytes were detected in the laboratory method blank samples or the field blank sample.

Surrogate Recoveries

No recovery was reported for WTPH-g surrogate bromobenzene for sample NMW-10A due to matrix interference. The laboratory control sample results also showed no recovery for the bromobenzene surrogate due to interference from the gas spike.

Matrix Spike/Matrix Spike Duplicate Surrogate Recoveries

Matrix spike/matrix spike duplicate recoveries were within control limits.

Laboratory Control Samples

The laboratory control sample analyzed for VOCs had low recoveries for several compounds. Samples associated with the laboratory control sample were reanalyzed (see above discussion regarding holding times) and a new laboratory control sample was analyzed. The laboratory control sample recovery results associated with the reanalysis were within control limits.

Duplicate Results

No laboratory duplicate analyses were performed for this data set. The RPDs for the field duplicate results for WTPH-g and VOC were less than 11 percent (control limit is 25 percent).

19 January 1998

**MEMORANDUM**

To: STF File  
From: Julie Reid  
Subject: Data Validation  
Second Quarter Groundwater Analytical Results  
K/J 966124.06

---

This memorandum summarizes the results of the data validation performed on the STF second quarter groundwater sample results. Eight groundwater samples (including one duplicate sample and two field blank samples) were collected from Pioneer Builders Supply on 19 and 20 August 1997 for the analysis of WTPH-d, WTPH-g, and VOCs. The following components were evaluated during data validation:

- Holding times (verified that samples were analyzed within the specified holding time)
- Laboratory method blank samples [verified that no analytes were present in method blanks and that a blank was analyzed every 20 samples (or more often) for each matrix]
- Field blank samples (verified that no analytes were present in the field blank samples)
- Surrogate spikes (verified that surrogate recoveries have been performed and control limits were met)
- Matrix spikes/matrix spike duplicate samples [verified that matrix spikes (for metal analyses) and matrix spike/matrix spike duplicates (for organic analyses) were analyzed every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met]
- Laboratory check samples (verified that laboratory check sample results, if submitted, met control limits)
- Laboratory duplicate samples (verified that duplicate analyses were conducted every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met)
- Field duplicate samples [calculated relative percent differences (RPDs) for each set of field duplicate samples].

Holding Times

All samples were analyzed within the specified holding times.

Blank Samples

No analytes were detected in the laboratory method blank samples or the field blank samples.



**MEMORANDUM**

STF File

19 January 1998

Page 2

Surrogate Recoveries

No recovery was reported for WTPH-g surrogate bromobenzene for sample NMW-10A due to matrix interference. The WTPH-g laboratory control, matrix spike, and matrix spike duplicate sample results also showed no recovery for the bromobenzene surrogate due to interferences from the gas spike.

Matrix Spike/Matrix Spike Duplicate Surrogate Recoveries

Matrix spike/matrix spike duplicate recoveries were within control limits.

Laboratory Control Samples

The recoveries for laboratory control samples analyzed with the groundwater samples were within the control limits.

Duplicate Results

No laboratory duplicate analyses were performed for this data set. The RPDs for the field duplicate results for WTPH-d, WTPH-g, and VOC were less than or equal to 25 percent (control limit is 25 percent), except for the results for 1,2,3-trichlorobenzene. RPD for 1,2,3-trichlorobenzene was 29 percent.

19 January 1998

**MEMORANDUM**

To: STF File  
From: Julie Reid  
Subject: Data Validation  
Third Quarter Groundwater Analytical Results  
K/J 966124.06

---

This memorandum summarizes the results of the data validation performed on the STF third quarter groundwater sample results. Eight groundwater samples (including one duplicate sample and two field blank samples) were collected from Pioneer Builders Supply on 5 and 8 December 1997 for the analysis of WTPH-d, WTPH-g, and VOCs. The following components were evaluated during data validation:

- Holding times (verified that samples were analyzed within the specified holding time)
- Laboratory method blank samples [verified that no analytes were present in method blanks and that a blank was analyzed every 20 samples (or more often) for each matrix]
- Field blank samples (verified that no analytes were present in the field blank samples)
- Surrogate spikes (verified that surrogate recoveries have been performed and control limits were met)
- Matrix spikes/matrix spike duplicate samples [verified that matrix spikes (for metal analyses) and matrix spike/matrix spike duplicates (for organic analyses) were analyzed every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met]
- Laboratory check samples (verified that laboratory check sample results, if submitted, met control limits)
- Laboratory duplicate samples (verified that duplicate analyses were conducted every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met)
- Field duplicate samples [calculated relative percent differences (RPDs) for each set of field duplicate samples].

Holding Times

All samples were analyzed within the specified holding times.

Blank Samples

No analytes were detected in the laboratory method blank samples or the field blank samples.

**MEMORANDUM**

STF File

19 January 1998

Page 2

Surrogate Recoveries

No recovery was reported for WTPH-g surrogate bromobenzene for sample NMW-10A or NMW-100 (duplicate of NMW-10A) due to matrix interference. The WTPH-g laboratory control, matrix spike, and matrix spike duplicate sample results also showed no recovery for the bromobenzene surrogate due to interferences from the gas spike.

Matrix Spike/Matrix Spike Duplicate Surrogate Recoveries

Matrix spike/matrix spike duplicate recoveries were within control limits.

Laboratory Control Samples

The recoveries for laboratory control samples analyzed with the groundwater samples were within the control limits.

Duplicate Results

No laboratory duplicate analyses were performed for this data set. The RPDs for the field duplicate results for WTPH-d, WTPH-g, and VOC were less than 58 percent (control limit is 25 percent).

8 April 1998

**MEMORANDUM**

To: STF File  
From: Julie Reid  
Subject: Data Validation  
Fourth Quarter Groundwater Analytical Results  
K/J 966124.06

---

This memorandum summarizes the results of the data validation performed on the STF fourth quarter groundwater sample results. Eight groundwater samples (including one duplicate sample and two field blank samples) were collected from Pioneer Builders Supply on 17 March 1998 for the analysis of WTPH-d, WTPH-g, and VOCs. The following components were evaluated during data validation:

- Holding times (verified that samples were analyzed within the specified holding time)
- Laboratory method blank samples [verified that no analytes were present in method blanks and that a blank was analyzed every 20 samples (or more often) for each matrix]
- Field blank samples (verified that no analytes were present in the field blank samples)
- Surrogate spikes (verified that surrogate recoveries have been performed and control limits were met)
- Matrix spikes/matrix spike duplicate samples [verified that matrix spikes (for metal analyses) and matrix spike/matrix spike duplicates (for organic analyses) were analyzed every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met]
- Laboratory check samples (verified that laboratory check sample results, if submitted, met control limits)
- Laboratory duplicate samples (verified that duplicate analyses were conducted every 20 samples for each matrix or at least for each batch of samples, where applicable, and that control limits were met)
- Field duplicate samples [calculated relative percent differences (RPDs) for each set of field duplicate samples].

Holding Times

All samples were analyzed within the specified holding times.

Blank Samples

No analytes were detected in the laboratory method blank sample or the field blank samples.



**MEMORANDUM**

STF File

8 April 1998

Page 2

Surrogate Recoveries

No recovery was reported for the WTPH-g laboratory control, matrix spike, and matrix spike duplicate sample results for the bromobenzene surrogate due to interferences from the gas spike.

Matrix Spike/Matrix Spike Duplicate Surrogate Recoveries

Matrix spike/matrix spike duplicate recoveries were within control limits.

Laboratory Control Samples

The recoveries for laboratory control samples analyzed with the groundwater samples were within the control limits.

Duplicate Results

No laboratory duplicate analyses were performed for this data set. The RPDs for the field duplicate results for WTPH-d, WTPH-g, and VOC were less than 10 percent (control limit is 25 percent).